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GLOSSARY OF TERMS USED IN OPTICAL TECHNOLOGY

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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GLOSSARY OF TERMS USED IN OPTICAL TECHNOLOGY

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GLOSSARY OF TERMS USED IN OPTICAL TECHNOLOGY

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 10 October 1959, after the draft finalized by the Optical and Mathematical Instruments Sectional Committee had been approved by the Engineering Division Council.

0.2 With a view to assisting the optical instruments industry, a series of Indian Standards is under preparation. Other standards in the series on which work has been initiated are for General Requirements for Optical Components, General Requirements for Optical Instruments and Optical Glass. This standard is intended to establish a glossary of terms used in optical technology. Reference to this standard will be made, in due course, in other Indian Standards of the series. This standard at present does not include mechanical engineering terms commonly applied to optical instruments, as it has been decided to prepare a separate standard for the use of different industries.

0.3 In preparing this standard, due consideration has been given by the Sectional Committee concerned to the terms used by producers, consumers and technologists in the country in this field. Terms used in other countries have also been studied.

1. SCOPE

1.1 This standard gives the definitions of terms used in optical technology, but does not include the more commonly used mechanical engineering terms.

2. GENERAL

2.1 Fundamentals

2.1.1 *Absorption* — The reduction in intensity of incident radiation during transmission through a medium and/or reflection at an interface.

2.1.2 *Achromatism* — The condition in which rays of two different colours are brought to a common focus/path.

2.1.3 *Airy Disc* — The diffraction pattern, consisting of a central bright disc surrounded by alternate dark and bright rings, which constitutes the image of a point object as formed by an optical instrument.

2.1.4 *Apochromatism* — The condition in which rays of three different colours are brought to a common focus.

2.1.5 *Catadioptric Systems* — Optical systems incorporating both reflecting and refracting elements as parts thereof.

2.1.6 *Catoptric System* — An optical system consisting of reflecting surfaces.

2.1.7 *Deviation* — The extent to which, in angular measure, a ray of light is deflected from its original path due to refraction and/or reflection.

2.1.8 *Diffraction* — The phenomenon showing the apparent bending of light rays around the edge of an object and the consequent spreading of light into the region of the geometrical shadow.

2.1.9 *Dioptric System* — An optical system consisting of refracting elements.

2.1.10 *Dispersion* — The separation of monochromatic components of complex radiation.

2.1.11 *Dispersive Power of a Refracting Medium* — It is measured by the expression $\frac{n_F - n_C}{n_d - 1}$, where n_d, n_F and n_C are respectively the refractive indices of the medium for yellow helium light and the blue and red lines of the hydrogen spectrum. Its reciprocal V is often referred to as the Abbe number.

2.1.12 *Double Refraction* — A phenomenon in which crystalline substances or transparent materials under mechanical, electrical or magnetic strain exhibit the property of dividing an incident ray of light into two rays, which pursue different paths in the crystal. Only one ray, called the ordinary ray, obeys Snell's law. The other is called the extraordinary ray.

2.1.13 *Electromagnetic Waves* — A travelling disturbance in space produced by the acceleration of an electric charge and comprising an electric field at right angles to a magnetic field, both moving at the same velocity in a direction normal to the plane containing the two fields. Radio waves, heat rays, light rays, X-rays, etc, are all electromagnetic waves, but differing in frequency.

2.1.14 *Fraunhofer Lines* — Dark lines in the sun's continuous spectrum caused by absorption of certain wave-lengths in the Solar Chromosphere.

2.1.15 *Frequency* — The number of waves passing per second through a point in the direction of propagation and is defined by the ratio of the velocity of light to the wave length of radiation.

2.1.16 *Halation and Spreading* — Halation, an effect commonly noticed with spectrum lines that have been greatly overexposed. Spreading is another photographic phenomenon in which the image on a photographic plate will not be confined only to the area on which the light is incident.

2.1.17 *Interference* — The phenomenon by which two or more superposed trains of waves of equal wave-length cause either an increase or decrease in intensity at a point in a medium due to the phase relationship between the wave trains at that point.

2.1.18 *Light* — Electromagnetic radiation capable of inducing visual perception.

2.1.19 *Opaque* — Impervious to light or radiation of particular wavelengths.

2.1.20 *Optical System* — An orderly arrangement of optical components, the constructional parameters of which are so adjusted as to give optimum performance of the instrument in which it is used.

2.1.21 *Optics* — The branch of Physics dealing with the study of light including instruments used to aid vision.

2.1.22 *Polarization* — The phenomenon by which a radiation having vibrations in a selective plane and orientation can be obtained. Polarization may be of three types, namely plane, circular or elliptical according to the type of vibrations.

2.1.23 *Radiation* — Emission of energy in the form of electromagnetic waves (or quanta). The term is also used for energy in this form.

2.1.24 *Rayleigh Criterion for Resolution* — Two infinitely narrow light sources or point sources are to be considered resolvable when they are separated by such an amount that the central diffraction maximum of one falls on the first diffraction minimum of the other.

2.1.25 *Reflection* — The phenomenon by which light rays are returned back in the same medium from which they are incident.

2.1.26 *Refraction* — The phenomenon by which a transmitted ray of light changes its direction at the interface of two media of differing refractive indices or in traversing an optically non-homogeneous medium.

2.1.27 *Refractive Index of a Transparent Material* — The ratio of the velocity of light in vacuum to its velocity in the material.

2.1.28 *Secondary Spectrum* — The residual dispersion between two wavelengths after achromatization.

2.1.29 *Source of Light* — A self-luminous (or reflecting) body from which light is emitted (or reflected).

2.1.30 *Spectral Analysis* — Analysis of the structural or chemical nature of a substance by the characteristic emission or absorption lines or bands produced by it in a spectrum.

2.1.31 *Spectroscopy* — Study of the radiations in a spectrum.

2.1.32 *Spectrum* — A dispersed image of a line or point source of radiation presenting an orderly arrangement of the radiation according to wave-length. It may appear continuous or present discrete lines or bands against a dark or bright background.

> NOTE — The visible portion of the spectrum and the infra-red and ultra-violet regions on either side of it cover the following ranges of wave-length:
>
> Infra-red region: a few millimetres to $7\cdot5\times10^{-4}$ mm
> Visible region: $7\cdot5\times10^{-4}$ to 4×10^{-4} mm
> Ultra-violet region: 4×10^{-4} to 1×10^{-6} mm

2.1.33 *Total Internal Reflection* — When a ray of light traverses from a denser medium to a rarer medium, the ray of light is totally reflected at the boundary of separation between the two media when the angle of incidence is greater than a certain critical value (critical angle). This phenomenon is called total internal reflection.

2.1.34 *Translucent* — Transmitting light mainly by diffuse transmission.

2.1.35 *Transparent* — Allowing light rays to be transmitted without noticeable absorption so as to be distinctly seen through.

2.1.36 *Velocity of Light* — The rate at which electromagnetic radiation is propagated in a medium.

2.1.37 *Wave-Front* — The envelope or leading portion of an advancing wave in which all points are in the same phase.

2.1.38 *Wave-Length* — The separation between corresponding points of successive wave fronts, in the same phase.

> NOTE — The units of wave-length in and near the visible region of the spectrum in common use are:
>
> 1 μ (micron) = 10^{-4} cm
> 1 mμ (millimicron) = 10^{-7} cm
> 1 Å (Ångström) = 10^{-8} cm

2.2 The Eye and Vision

2.2.1 *Accommodation* — The change of power of the crystalline lens accompanying the action of the ciliary muscle due to which objects at various distances are brought into focus involuntarily by the eye.

2.2.2 *Adaptation* — The power of the eye to adapt itself to different lighting conditions.

2.2.3 *Aqueous Humour* — The watery fluid filling the space between the cornea and the lens of the eye.

2.2.4 *Astigmatism of the Eye* — A defect of the eye caused by its having different optical powers in different meridians resulting in the image of a point source being drawn out into a short line.

2.2.5 *Binocular Vision* — The view obtained by observation of an object through two oculars.

2.2.6 *Blind Spot* — The spot insensitive to light on the retina where the sensitive layer is absent due to the optic nerve penetrating through it.

> Note — Rods are responsible for night vision and predominate in the peripheral positions of the retina. Cones are associated with acute vision and exist exclusively in the fovea centralis.

2.2.7 *Colour Blindness* — The defect of vision in some individuals who cannot perceive or distinguish certain portions of the visible spectrum.

2.2.8 *Colour Sensitivity* — The degree of visual sensation or the sensitivity of the eye to radiant energy which depends upon the wave-length.

2.2.9 *Cornea* — A glassy transparent membrane that forms the front covering of the eye.

2.2.10 *Crystalline Lens* — A double convex lens formed of a highly elastic thick jelly-like substance of varying refractive index and located just behind the iris and is the chief image producing element of the eye.

2.2.11 *Fovea Centralis* — The central spot of the macula lutea (yellow spot) of about 0·5 mm^2 in area, where the visual acuity is greatest.

2.2.12 *Glare* — The various effects produced on the eye due to the presence in the filed of view of an object much brighter than the general level of brightness of the field or of the object under observation.

2.2.13 *Hypermetropia* — A condition of the eye in which, with the eye at rest, parallel rays of light converge towards a focus behind the retina. This is popularly known as long- or far-sightedness.

2.2.14 *Iris* — A diaphragm in front of the eye consisting of a pigmented membrane and acting as self-adjusting aperture according to the brightness of the field of view.

2.2.15 *Luminous Efficiency of Radiation* — The quotient of luminous flux by the corresponding radiant flux.

2.2.16 *Luxon* — The retinal illumination produced by a surface having a luminance of one candela per square metre when the pupil area is one square millimetre.

2.2.17 *Macula Lutea or Yellow Spot* — A slightly elliptical yellow region on the retina of about 2·5 mm diameter where vision is most clear.

2.2.18 *Mesopic Vision* — The vision in conditions intermediate between those of photopic and scotopic vision.

2.2.19 *Myopia* — A condition of the eye in which, with the eye at rest, parallel rays of light come to a focus in front of the retina. This is popularly known as short-sightedness.

2.2.20 *Optic Nerve* — The nerves conveying the retinal sensations to the brain.

2.2.21 *Perception of Contrast: Fechner Fraction* — When a photometric field of two equal portions is seen by the eye, the least perceptible difference (dB) in brightness (B), often expressed as dB/B (Fechner Fraction), measures the ability of the eye to perceive brightness contrast and achieve photometric match between the two parts of the field.

2.2.22 *Persistence of Vision* — A phenomenon in which the impression of the image on the retina remains for a small fraction of a second (normally one-sixteenth of a second) even after the object has been removed from sight.

2.2.23 *Photopic Vision* — The vision depending essentially on the cones. It is generally associated with adaptation to a luminance level of several candelas per square metre.

2.2.24 *Pupil* — The effective aperture in the iris through which light enters the eye.

2.2.25 *Purkinje Effect* — The displacement of the wave-length of maximum luminous efficiency to shorter wave-lengths, in passing from photopic to scotopic vision.

2.2.26 *Retina* — The innermost coating of the eye consisting of a delicate film of reticulated structure of light sensitive nerve fibres and cells directly connected with the optic nerve.

2.2.27 *Rods and Cones* — Minute light sensitive bodies in the shape of rods and cones attached to the nerve-fibres of the optic nerve, which are mainly instrumental in seeing objects.

2.2.28 *Scotopic Vision* — The vision depending essentially on the rods. It is generally associated with adaptation to a luminance level below some hundredths of a candela per square metre.

2.2.29 *Stereoscopic Acuity* — The ability of the eyes to resolve and see as such objects which are at varying distances from the observer.

2.2.30 *Stereoscopic- or Stereo-Vision* — The observation of an object or objects under conditions which present a different image to each eye to produce a solid or three dimensional effect.

2.2.31 *The Eye* — The organ of sight in man or animal by which the physical perception of the external objects is accomplished.

2.2.32 *Threshold of Vision* — The minimum perceptible luminance for the fully dark adapted eye. This threshold usually lies between 10^{-4} and 10^{-3} lux for an extended field.

2.2.33 *Veiling Glare* — The effect on vision due to the inter-position between the eye and the object looked at of a luminous veil or an illuminated haze, thereby resulting in a reduction of contrast.

2.2.34 *Vernier or Contour Acuity* — The ability of the eye to perceive relative position or detect the absence of coincidence or alignment between two objects. It is measured in terms of the minimum angular separation below which failure of coincidence cannot be appreciated.

2.2.35 *Visibility Curve* — The curve showing the graphical relation between the relative luminous efficiency or visibility of radiation for different wave-lengths in the visible part of the spectrum.

2.2.36 *Visual Acuity (Resolving Power)* — Acuity or sharpness of vision is the ability of the eye to distinguish fineness of details and is measured by the minimum angular separation which permits resolution for two point objects.

2.2.37 *Vitreous Humour* — The jelly like transparent substance filling the space between the lens and the retina of the eye.

2.3 Photometry and Illumination

2.3.1 *Brightness or Luminosity* - - The attribute of visual sensation according to which an area appears to emit more or less light.

> Note — This attribute is the psychosensorial correlate (or nearly so) of the photometric quantity luminance.

2.3.2 *Candela (cd)* — The unit of luminous intensity. It is of such a magnitude that the luminance of a full radiator (black body) at the temperature of solidification of platinum is 60 units of luminous intensity per square centimetre.

2.3.3 *Colorimetry* — The science of the precise measurement of the hue, purity and brightness of a colour.

2.3.4 *Densitometry* — The subject dealing with the measurement of photographic densities on an exposed plate.

2.3.5 *Efficiency of a Luminous Source* — The ratio of the total luminous flux emitted to the total power consumed. It is usually expressed in lumens per watt or in lumens per thermal unit per unit of time.

2.3.6 *Foot-Candle* — A unit of illumination. An illumination of one lumen per square foot.

2.3.7 *Foot-Lambert* — A unit of luminance. It is equal to the luminance of a uniform diffuser emitting or reflecting one lumen per square foot.

2.3.8 *Full Radiator* — A light source emitting radiation, the spectral distribution of which is dependent on the temperature only and not on the material and nature of the source.

2.3.9 *Illumination at Any Point of a Surface* — The surface density of luminous flux at a point.

2.3.10 *International Candle* — The former unit of luminous intensity derived from the Carcel and pentane lamps and maintained by means of carbon filament electric lamps by the national standardizing laboratories of UK, USA and France. It has been replaced since 1948 by Candela by international agreement, the two being related by the equation 60 cd = 58·9 ± 0·2 international candles.

2.3.11 *Lambert* — A unit of luminance. It is equal to the luminance of a perfectly uniform diffusing surface emitting or reflecting one lumen per square centimetre.

2.3.12 *Lumen* (*lm*) — The unit of luminous flux. It is the flux emitted in a unit solid angle of one steradian by a point source having a uniform intensity of one candela.

2.3.13 *Luminance* (*l*) *at a Point of a Surface in a Given Direction* — The quotient of the luminous intensity in a direction of an element of the surface containing the point, by the area of the orthogonal projection of this element on a plane perpendicular to the direction; and expressed in candela per unit area. It is a measure of the physical stimulus of the radiation as contrasted with the term brightness or luminosity which refers to the visual sensation.

2.3.14 *Luminosity* — The attribute of visual perception in accordance with which an area appears to emit more or less light.

2.3.15 *Luminous Energy* — The time integral of luminous flux.

2.3.16 *Luminous Flux* — The quantity, characteristic of radiant flux, which expresses its capacity to produce visual sensation, evaluated according to the values of relative luminous efficiency for the light adapted eye.

2.3.17 *Luminous Intensity of a Point Source in Any Direction* — The quotient of the luminous flux emitted by a source, or by an element of a source, in an infinitesimal cone containing the given direction, by the solid angle of that cone.

2.3.18 *Lux or Metre-Candle* — The practical unit of illumination. It is one lumen per. square metre.

2.3.19 *Mean Horizontal Candle Power* (*mhcp*) — The average value of the luminous intensity in all directions in a horizontal plane passing through the luminous centre of the source.

2.3.20 *Mean Spherical Candle Power* (*mscp*) — The average value of the luminous intensity of a source in all directions. It is equal to the total luminous flux emitted by the source divided by the solid angle (4π).

2.3.21 *Microphotometry or Microdensitometry* — The subject dealing with the measurement of the transmission factor of an exceedingly small area of an exposed photographic plate, for example, intensities of spectral lines or the density of the sound track on a kinematograph film.

2.3.22 *Photometry* — The branch of Applied Physics dealing with the measurement of the luminous intensities of light sources and illumination of surfaces.

2.3.23 *Primary Standard* — A standard light source reproducible from a specification. The present international standard is a full radiator at the temperature of solidification of platinum.

2.3.24 *Radiant Flux* — Power emitted, transferred or received in the form of radiation.

2.3.25 *Spectrophotometry* — The branch of photometry which deals with the quantitative measurement of the relative intensity of radiation in different parts of its spectrum.

2.3.26 *Sub-Standard* — A suitable lamp which has been measured by comparison with the primary standard (or with other sub-standards) so that its luminous intensity in a defined direction is known to the highest accuracy in photometric measurement.

2.3.27 *Working Standard* — A lamp which has been measured by comparison from time to time by reference to a sub-standard to an accuracy sufficient for ordinary photometric work.

3. MATERIALS USED IN OPTICAL INDUSTRY

3.1 **Abrasive** — A substance like emery, carborundum, diamond powder or dust, etc, used in a powdered state for grinding down surfaces of glass or crystals.

3.2 **Anti-Reflection Coating Materials** — Materials used for coating the surfaces of optical elements to minimize the loss of light by reflection and thereby increasing transmission through optical systems. (The material should normally have a refractive index equal to the square root of the refractive index of the glass.)

3.3 Calcite — Natural crystalline calcium carbonate ($CaCO_3$), also called Iceland Spar.

3.4 Canada Balsam — A straw coloured natural resin in an organic solvent used as an adhesive for lenses and optical elements.

3.5 Cement — A transparent adhesive substance applied when soft as a bonding medium between optical components.

3.6 Crown Glass — A type of optical glass not containing lead among its constituents and having low dispersion and usually low in refractive index.

3.7 Desiccant — A substance capable of absorbing/adsorbing water vapour from its surrounding atmosphere.

3.8 Developer — A chemical solution used to bring out the latent image in the exposed areas of the light sensitive layer of a plate, film or paper.

3.9 Fixer — An agent for the conversion of unreduced silver salts in the sensitized layer after development into soluble salts which can be eliminated by washing and thus fix the image on the base.

3.10 Flint Glass — A type of optical glass containing lead oxide and usually having high dispersion and high refractive index.

3.11 Fluorspar (Fluorite) — Natural crystalline calcium fluoride (CaF_2), normally colourless and having ultra-violet transmission up to 125 millimicrons.

3.12 Fuller's Earth — A fine-grained earthy substance, similar to clay, used with rouge in polishing on cloth polisher.

3.13 Fungicide — A chemical which is lethal to fungi and is often used in some form in optical instruments to eliminate mould growth.

3.14 HT Cement — A synthetic plastic (butyl methacrylate) used as an optical cement by a process of curing to achieve polymerization, thereby resulting in a bonded film of high mechanical stability.

3.15 Iceland Spar (Calcite) — A very pure transparent and crystalline form of calcium carbonate, noted for its double refraction or birefringence and used in the construction of Nicol prism.

3.16 Immersion Oil — A liquid like cedar wood oil used to fill the gap between the specimen under examination and a high power microscope objective, to obtain a higher numerical aperture.

3.17 Impregnating Materials—Materials used for filling, by impregnation under pressure, the pores of porous castings employed in the construction of optical instruments.

3.18 Intensifiers — Materials used for intensification of the optical density of an image in the photographic negative prints.

3.19 Luting Optical — A tacky plastic composition, usually incorporating a fungicide and employed for sealing the joints of instruments as a means of tropic-proofing them.

3.20 Mica — A natural mineral (silicate of aluminium with magnesium, iron or alkali metals), generally transparent with perfect basal cleavage, the laminæ being flexible.

3.21 Opal Glass — Glass which is opalescent or white and made by the addition of fluorides (for example, fluorspar and cryolite) to the glass mixture; sometimes used to diffuse light.

3.22 Optical Glass — A glass of special quality expressly made for its optical qualities from pure selected materials under controlled conditions and so treated that the finished product is homogeneous and as transparent as possible for the whole visible spectrum and its contiguous spectral regions.

3.23 Optical Plastic — A transparent synthetic solid material either thermosetting or thermoplastic, often used for cementing optical elements or as colour filters or for mass production of not too precise optical parts. Methyl methacrylate, polysterene, cellulose caprate, cellulose acetate and cellulose nitrate are some such materials.

3.24 Orthochromatic Emulsion — Emulsion which registers visual radiations correctly apart from colour, such emulsions being sensitive to all colours except red.

3.25 Panchromatic Emulsion — Emulsions which are reasonably sensitive photographically to all visible radiations particularly towards the red end of the spectrum.

3.26 Photographic Developer — Reducing agent for silver salts, usually polyhydric phenol or their derivatives, which act on the light sensitized silver halide grains and reduce them to metallic silver.

3.27 Photographic Emulsion — The light sensitive coating on a suitable base.

3.28 Pitch — A fusible, more or less solid, material containing bituminous or resinous substances, used in preparing polishers making blocks of optical components and for holding them otherwise for processing.

3.29 Polisher — A felt, cloth, taffeta, pitch or paper, as a soft and supple support for the polishing material for final processing of glass surfaces.

3.30 Polishing Rouge—Red oxide of iron (Fe_2O_3) in powdered form, used for polishing optical surfaces. Cerium oxide and alumina are other materials used for the same purpose.

3.31 Quartz — Natural crystalline silica (SiO_2) occurring as a white opaque mass, but occasionally as colourless transparent crystals having ultra-violet transmission down to 200 millimicrons.

3.32 Reducing Agents — Chemical substances which remove silver proportionately from all parts of the image, thus reducing the effects of over-exposure.

3.33 Sapphire — A fine blue transparent variety of crystalline corundum. Both natural and artificial sapphires are used for instrument jewels.

3.34 Sealing Materials — Materials used for effecting air-tight joints in instrument assembly.

3.35 Selinite — A naturally occurring colourless and transparent variety of gypsum.

3.36 Spectacle Crown — A type of crown glass used specially for making spectacle lenses and usually of refractive index 1·52.

3.37 Tourmaline — Natural crystalline silicates of various metals containing boron. These crystals are birefringent and have the additional peculiar property of absorbing the ordinary ray when more than 2 mm thick.

4. PROCESSING METHODS

4.1 Adhesing — Joining two polished pieces of optical glass by heat treatment without distortion.

4.2 Aluminizing — Deposition of a layer of aluminium on a polished surface by evaporation or sputtering to give a highly reflecting surface.

4.3 Annealing — A process of slow heating of glass to a proper temperature and subsequent conditioned cooling with a view to relieve stresses and strains in slabs or moulded glass.

4.4 Anodizing — Oxidation of exposed aluminium surfaces for protection and sometimes for dyeing.

4.5 Aspherize — To depart deliberately from sphericity of surface.

4.6 Balsamming — Cementing two or more optical components into a single unit using Canada Balsam or similar optical cement.

4.7 Blocking — Sticking components with pitch composition resin, wax or plaster of paris on to a properly shaped metal surface before polishing or grinding.

4.8 Block Setting — Correcting the final setting in a block before polishing or grinding by means of a template.

4.9 Blooming — Deposition of thin films of fluorides of certain alkali earth metals to a thickness of quarter wave-length for reducing surface reflection losses.

4.10 Centring — The process of mounting a lens for edging so that the mechanical axis of rotation is coincident with the optical axis.

4.11 Chamfering — Removal of sharp edges and corners of optical components by grinding.

4.12 Collimation — The process of aligning the various parts of an optical system.

4.13 Curving — Grinding a flat surface to the required curvature.

4.14 Desiccation — Drying up the interior of an assembled instrument to eliminate water vapour as an aid to tropic-proofing or tropicalization.

4.15 Edging — The process of giving a smooth contour to the periphery of a lens by grinding.

4.16 Elutriation/Levigation — The process of selection used for fine emery.

4.17 Etching — Forming a pattern on a glass plate by the chemical action of hydrofluoric acid, the required pattern being formed on the 'resist' coated glass, with the pattern only being exposed.

4.18 Figuring — Correcting local faults on optical surfaces.

4.19 Fumigation — Exposure of interior surfaces of an assembled instrument to the vapours of antiseptic materials like formaldehyde and methanol, as an aid to tropic-proofing or tropicalization.

4.20 Granularity — A measure of the size and distribution of the grains of photographically sensitive material embedded in the emulsion.

NOTE — The sensation of the graininess resulting from an excessive enlargement of a negative is a result of the granularity of the emulsion.

4.21 Grinding — The process of reducing the surface to its required shape or angle by using abrasives.

4.22 Hardening — The process of hardening the gelatin emulsion in a photographic plate or film by a suitable agent (formalin) to make it insoluble and more permanent.

4.23 Intensification — Increase of contrast in a photographic negative or print by chemical means by further deposition, usually of mercury, on exposed parts.

4.24 Marking — The initial layout on a block of optical glass with a grease pencil for economical utilization of material before sawing or cutting as well as for rejecting defective portions.

4.25 Photo-Etching — Etching the required pattern on glass or metal where the pattern on the ' resist ' is formed by a photographic process, instead of by mechanical means.

4.26 Photoprinting — A process of printing a pattern by photographic means.

4.27 Polishing — A process in which the smooth surface is rendered transparent by rubbing the surface against the polishing tool with rouge or other similar material.

4.28 Roughing — Grinding the component, using hard abrasives, roughly to the required size and shape.

4.29 Ruling — Drawing lines (or patterns) using a diamond point.

4.30 Shanking Off/Nibbling Off — The operation of cutting off the corners of square plates with a view to bringing them approximately to the right size close to the final form.

4.31 Silvering — Deposition of a coat of silver on a polished glass or metal surface, either by chemical, electrochemical or evaporation method to give a highly reflecting surface.

4.32 Slitting — The process of cutting through glass and even harder substances by the edge of a soft sheet-iron disc or wire saw charged with diamond dust or by a disc of abrasive material.

4.33 Smoothing — Continuation of trueing with still finer abrasives prior to polishing.

4.34 Sputtering — Formation of very fine grained coatings of metal upon surfaces of glass, quartz, etc, by the disintegration of the metal cathode in a vacuum tube due to bombardment by positive ions.

4.35 Trepaning — Drilling cylindrical sections of required diameter out of a slab of optical glass.

4.36 Tropicalization — A technique forming part of the original design with a view to achieving lasting protection against tropical deterioration.

4.37 Tropic-Proofing — It is an *ad hoc* technique of providing temporary protection against tropical deterioration.

4.38 Trueing — Grinding of a rough curved surface of an optical component against a master tool to impart the desired radius of curvature to the working surface.

5. OPTICAL COMPONENTS

5.1 Achromatic Lens — A combination of lenses having such powers and different dispersions as to bring rays of two colours of the spectrum to a single focus.

5.2 Amici Prism — A prism used to produce 90° deviation with simultaneous inversion of the image.

5.3 Analyser — A polarizer used to detect polarized light.

5.4 Anastigmat Lens — A photographic lens corrected for astigmatism for one obliquity and providing a reasonably flat field of good definition.

5.5 Aplanatic Lens — A lens free from spherical aberration and coma.

5.6 Apochromatic Lens — A combination of lenses having such powers and different refractive indices as to bring rays of three colours to a single focus.

5.7 Aspheric Lens — A lens whose surfaces (either one or both) are given different curvatures at different zones to eliminate spherical aberration and to obtain better correction of the optical system in which it is used.

5.8 Biprism — A prism of large apex angle forming two images of a point source of light, which act as coherent sources for interference fringes.

5.9 Compensating Filters — Filters used to adjust the light entering a photographic system in order to fulfil some particular conditions required in colour photography.

5.10 Condenser — An optical device used to converge the incident light on to an object.

5.11 Contrast Filters — Filters used selectively to modify the brightness of some special colour or group of colours.

5.12 Cover Glass — A thin transparent glass disc used to protect microscope specimens.

5.13 Cylindrical Lens — A lens at least one of whose surfaces is cylindrical resulting in magnifying the image of an object in the direction perpendicular to the axis only.

5.14 Dark Field Condenser — Condenser used in microscopy for oblique illumination of specimens. The objects are observed by the scattered light against a dark backgrounnd.

5.15 Dove Prism — A prism used to revert the image without deviation of the beam or displacing the axis of the beam. This is used only in collimated light.

AMENDMENT NO. 2 MARCH 1984

TO

IS:1399-1959 GLOSSARY OF TERMS USED IN OPTICAL TECHNOLOGY

Alteration

(*Page 4, clause 2.1.25*) - Substitute the following for the existing clause:

'2.1.25 *Reflection* - The phenomenon by which light rays are returned in the same medium from which they are incident.'

(EDC 36)

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5.16 Dry Objective — A microscope objective whose object space is air.

5.17 Eye Lens — The lens or system of lenses closest to the eye in an eyepiece.

5.18 Eyepiece — A lens system used in an optical instrument nearest to the eye for observing the image formed by the objective.

5.19 Field Lens — A lens in an eyepiece system farthest from the eye and used to collect the rays of the image field at large angles.

5.20 Filter — A transparent material containing a dye or other light absorbing medium with a view to modifying the intensity or colour of light being admitted to or transmitted through an optical instrument.

5.21 Focal Plane Shutter — A shutter with a slit of fixed or variable width which is made to pass rapidly just in front of the film which is in the focal plane of the objective.

5.22 Graticule (Reticule) — Optically polished glass marked with reference lines or evaluated patterns, suitably positioned in the focal plane of optical systems for precise estimation measurement.

5.23 Grating — A plane or spherical surface having a periodic variation of amplitude or phase transmission or reflection. This is commonly produced by ruling uniformly spaced grooves on the surface.

5.24 Inter Lens Shutter — A shutter situated at or near the iris diaphragm of the lens.

5.25 Inversion Objective — A microscope objective whose object space between the cover glass and the lens surface is filled with a special oil to increase the numerical aperture beyond unity.

5.26 Iris-Diaphragm — A variable diaphragm whose aperture can be controlled to allow the passage of light.

5.27 Leman Prism — A prism used for lateral displacement of the image with its simultaneous inversion by means of a roof.

5.28 Lens — A refracting medium bounded by two surfaces of which one or both may be spherical aspheric or cylindrical. Each of these surfaces may be convex, concave or plane.

5.29 Mirror — A highly polished plane or curved surface which reflects the major portion of the incident light.

5.30 Negative Lens — A lens which increases the divergence or decreases the convergence of the incident light.

5.31 Nicol Prism — A cemented prism combination made of Iceland Spar used for obtaining plane-polarized light.

5.32 Objective — The lens or system of lenses in an optical instrument which forms a real image of the object under observation.

5.33 Orthochromatic Filters — Filters used to correct the selective sensitiveness of photographic materials in order to give a reproduction of the brightness of coloured objects more closely approximating that perceived by eye.

5.34 Pentagonal Prism — A five-sided prism used to deviate a beam of light through 90° in the same plane even when the beam is not exactly normal to the incident face.

5.35 Phase Plate — A plate partially covered by a thin layer of material that is used in phase contrast systems to introduce a phase difference (and sometimes absorption) between the direct and the diffracted beams.

5.36 Polarizer — A device which causes the polarization of unpolarized light.

5.37 Polaroid (*a Trade Name*) — A transparent thin film of oriented complex molecules, suitably treated, for producing plane-polarized light.

5.38 Porro Prism — A reflecting prism used to reverse the image in the plane in which reflection takes place.

5.39 Positive Lens — A lens which increases the convergence or decreases the divergence of the incident light.

5.40 Prism — A transparent hollow or solid body of refracting material bounded by four or more plane faces.

5.41 Rhomboidal Prism — A prism used only to displace the axis of beam without introducing deviation, inversion or reversion.

5.42 Roof Prism — Any type of reflecting prism in which reversion is performed with a roof.

5.43 Selective Filters — Filters used for two- or three-colour photography with their corresponding synthetic projection filters.

5.44 Shutter — A device usually automatic to admit and cut off light for a predetermined interval of time to enable photographic exposures to be made.

5.45 Telephoto Lens — A camera objective with an equivalent focal length considerably greater than its back focal length.

5.46 Test Plates — Optically polished plates, either flat or spherical, worked to a high standard of optical precision and used for examining surface errors.

5.47 Tetrahedron Prism/Corner (Cube) Prism — A prism bounded by four triangular faces, three of which are mutually perpendicular to one another.

5.48 Traviss Expanding Stop — It is a variable sized opaque stop used with dark ground illumination system, operated on similar lines to an iris diaphragm.

5.49 Wave Plate — Thin sections of birefringent material of suitable thickness used to introduce phase differences in incident radiation.

5.50 Wirth Prism — A dove prism equipped with a roof at the reflecting surface to cause inversion.

6. OPTICAL INSTRUMENTS

6.1 Microscopes

6.1.1 *Binocular Microscope* — A compound microscope with one objective and two eyepieces for simultaneous observation of the image with both eyes for comfort of vision.

6.1.2 *Comparison Microscope* (*Micro Comparator*) — A special microscope with two objectives and one eyepiece intended for simultaneous observation of two objects for comparison purposes.

6.1.3 *Compound Microscope* — An instrument in which the primary magnification of the objective and the secondary magnification of the eyepiece are compounded suitably to give the necessary magnification and resolution.

6.1.4 *Dissecting Microscope* — A simple microscope mounted on strong base for hand rest and a transparent stage for holding and dissecting specimens.

6.1.5 *Electron Microscope* — A microscope of very high magnification and resolution which makes use of a beam of electrons for the formation of an image to the required magnification.

6.1.6 *Interference Microscope* — A microscope by which objects are made visible by interference between two parts of the incident beam of light; one of them modified in phase by passage through the specimen, the other remaining unmodified.

6.1.7 *Metallurgical Microscope* — A compound microscope with vertical illumination for examination of metallurgical specimens.

6.1.8 *Microscope* — An instrument used for the observation of minute objects under magnification.

6.1.9 *Pathological Microscope* — A research type of microscope used by pathologists for examination of blood, sputum, etc.

6.1.10 *Petrological Microscope* — A polarizing type of microscope used for examining mineral specimens.

6.1.11 *Phase Contrast Microscope* — It is a compound microscope to observe detail in specimens of inherently low contrast by the introduction of a phase plate which delineates changes of phase introduced by the structure of the specimens as changes in brightness or colour.

6.1.12 *Polarizing Microscope* — A compound microscope where the object is illuminated by means of plane-polarized light and the eyepiece fitted with an analyser and a graduated circle.

6.1.13 *Projection Microscope* — A microscope for projecting the magnified image of an object on to a screen.

6.1.14 *Reflecting Microscope* — A special type of compound microscope, using a reflecting type of objective.

6.1.15 *Simple Microscope* — A simple positive lens or a combination of lenses mounted in cell and used as a magnifier.

6.1.16 *Stereoscopic Microscope* — Two compound microscopes in a simple body so arranged as to give a stereoscopic presentation of the image of the object. (A large working distance and relatively low magnification are the characteristics of this microscope.)

6.1.17 *Tool Maker's Microscope* — Microscope for the study of profile of opaque objects with or without projection and fitted with micrometers and angle measuring devices for carrying out measurements.

6.1.18 *Travelling Microscope* — A low magnification compound microscope sliding over a graduated scale used for linear measurements.

6.1.19 *Ultra Microscope* — A compound microscope with special type of illumination for the examination of very minute particles held in liquid or gaseous suspension.

6.1.20 *Ultra-Violet Microscope* — A microscope using ultra-violet radiations for illuminating the object to obtain more resolution and better contrast facilities.

6.1.21 *Universal Microscope* — A microscope combining the various features of research metallurgical and petrological microscope and used either for visual observation or for taking photographs of the image. This is usually characterized by very rigid construction and built in illumination.

6.2 Telescopic Instruments

6.2.1 *Astronomical Telescope* — A high magnification telescope which forms an inverted image of a celestial object in astronomical observations.

6.2.2 *Binoculars* — Two telescopes of identical optical characteristics joined together to form a single instrument which presents to both eyes a magnified stereoscopic view of the objects.

6.2.3 *Finder/Locating Telescope* — An auxiliary telescope, usually of large field of view and low magnification, used in conjunction with a telescope of high magnification and small field of view for easy location of the objects to be viewed.

6.2.4 *Galilean Telescope* — A telescope with a converging objective and a diverging eye lens, giving an erect image.

6.2.5 *Level* — A survey instrument used for determining the difference in heights between two points, using a telescope for sighting and a spirit bubble for levelling.

6.2.6 *Panoramic Telescope* — A periscopic telescope where the object glass assembly can be rotated through 360° to give a panoramic view but the eyepiece remaining stationary. It gives an erect image of the object in all positions of the object glass assembly.

6.2.7 *Prismatic Telescope* — A terrestrial telescope in which the erect image is obtained by using prisms.

6.2.8 *Rangefinder* — An instrument for determining the distance of a distant object, the distance being termed ' range ' (a term from ' gunnery ').

6.2.9 *Reflecting Telescope* — A telescope in which the objective is of a reflecting type.

6.2.10 *Refracting Telescope* — A telescope in which the objective consists of a system of lenses.

6.2.11 *Sighting Telescope* — A terrestrial telescope, usually of large field of view and low magnification, used in conjunction with a main equipment for easy location of the object to be viewed.

6.2.12 *Telescope* — An optical instrument for the observation of distant objects under magnification.

6.2.13 *Terrestrial Telescope* — A telescope which gives an erect image of an object and used for observing terrestrial objects.

6.2.14 *Theodolite* — A survey instrument used for the precise measurement of angles with a telescope as the means of sighting.

6.2.15 *Transit* — An astronomical telescope suitably mounted on bearings for its rotation through 360° on vertical and horizontal planes.

6.3 Cameras and Projectors

6.3.1 *Camera* — An instrument used for photographing the images of objects.

6.3.2 *Cine Projector* — A projector with provision for successive intermittent projection of a series of pictures of a cine film.

6.3.3 *Diascope* — A projector which produces an image of a transparency.

6.3.4 *Enlarger* — An optical arrangement which produces an enlarged image of an object by projection normally used in photography.

6.3.5 *Epidiascope* — A projector which combines the features of an episcope and a diascope and can, therefore, be used for the projection of the image of an opaque or transparent object.

6.3.6 *Episcope* — A projector which produces an image by reflection from the surface of an opaque object.

6.3.7 *Folding Camera* — A camera where the distance between the lens and the photographic plate is adjustable and which can be folded for portability.

6.3.8 *High Speed Camera* — A camera for taking a very large number of pictures of a fast moving object within a very short time interval, for example, of projectiles from guns.

6.3.9 *Movie Camera* (*Motion Picture Camera*) — A camera for taking continuous sequence of photographs of an object.

6.3.10 *Panoramic Camera* — A camera intended for taking pictures subtending very wide angles, generally obtained by rotation of the camera on a fixed axis.

6.3.11 *Photostat Camera* — A camera intended for rapid duplication of documents.

6.3.12 *Process Camera* — A camera equipment intended for production of line and half tone negatives and positives for photo-mechanical purposes.

6.3.13 *Projector* — An optical instrument in which the magnified image of an object is thrown on to a screen for ease of observation.

6.3.14 *Reflex Camera* — A camera in which focussing can be performed by observing the image of an object on a ground glass plate, mounted in a plane at right angles to the recording (photographic) plate, even while the sensitized plate is in its position.

6.3.15 *Stereo Camera* — A camera designed to record two images of an object simultaneously from two different angles.

6.3.16 *Still Camera* — A camera used for taking single photographs of an object.

6.3.17 *Behind-the-Lens Shutter* — A shutter positioned as closely as possible to the back element of a photographic lens.

NOTE — In certain cameras with meniscus lenses, the shutter may be placed in front of the lens.

6.3.18 *Effective Aperture of a Well-Defined Photographic Objective for a Given Setting of the Diaphragm* — An opening, equivalent to a right section of the largest beam of parallel light from an axial object point that is transmitted by the lens. It is specified by its diameter.

6.3.19 *Effective Exposure Time* (t_e) — The product of the total open time (t_o) and the efficiency (η), that is, $t_o . \eta$ for a particular exposure setting of shutter.

6.3.20 *Hyper-Focal Distance* — When a lens is focussed on an object situated at hyper-focal distance, all objects situated between ∞ and half this distance will be in acceptably good focus.

6.3.21 *Inter-Lens Shutter* — A shutter positioned between the front and back elements of a photographic lens.

6.3.22 *Maximum Aperture* — Usually referred by the *f*-number obtained with the effective aperture as large as possible, in the case of a photographic lens.

6.3.23 *Shutter Efficiency* (η) — The ratio of the quantity of light actually transmitted by the shutter at any particular shutter setting to the quantity of light that would have been transmitted had the shutter been fully open to that diaphragm opening for the total open time.

6.3.24 *Total Open Time* (t_o) — The time interval for a particular exposure setting of shutter from the beginning of the opening period to the end of the closing period.

6.3.25 *View-Finder* — A visual aid provided in a camera to ensure that the subject is included in the useful field of the taking lens at the time of exposure.

6.4 Other Instruments

6.4.1 *Autocollimator* — An instrument which combines the functions of a collimator and telescope.

6.4.2 *Coelostat* — An instrument consisting of a clock driven mirror rotating about an axis in its own plane and used to reflect continuously the same region of the sky into the field of view of a fixed telescope.

6.4.3 *Collimator* — An optical device consisting of an objective and a graticule in its focal plane to simulate the conditions of an object at infinity and used for the alignment of optical systems.

6.4.4 *Colorimeter* — An instrument used for the measurement/comparison of the hue, purity and brightness of a colour.

6.4.5 *Comparator* — An instrument for the precise measurement of small variations in linear dimensions.

6.4.6 *Endoscope* — A tubular optical instrument of small aperture used for the examination of inaccessible interior parts of the human body.

6.4.7 *Exposure Meter* — A photo-electric device used to determine the optimum exposure conditions in terms of the brightness of the chosen area in the field.

6.4.8 *Heliograph* — An instrument similar to the heliostat but fitted with a spring device to signal long and short flashes.

6.4.9 *Heliostat* — An instrument similar to coelostat specially used for photographic and spectroscopic study of the sun.

6.4.10 *Interferometer* — A research and a workshop instrument designed for measurement of observation of optical path difference and the effects thereof using the principle of interference.

6.4.11 *Interferoscope* — An optical instrument used to examine surfaces for flatness without bringing the two surfaces into actual contact.

6.4.12 *Microphotometer or Microdensitometer* — An instrument used for the measurement/recording of the photographic densities over minute areas of an exposed plate.

6.4.13 *Opthalmometer* — An instrument for measuring the radius of curvature of the cornea of the human eye.

6.4.14 *Optical Micrometer* — An optical device used for measuring small linear displacements utilizing the principle of deviation of a beam of light when passed through a plane parallel plate of glass.

6.4.15 *Periscope* — An optical instrument designed for looking over the top of obstacles.

6.4.16 *Photometer* — An instrument used for measuring photometric quantities.

6.4.17 *Polarimeter* — An instrument for measuring the amount of rotation of the plane of polarization in an optically active substance.

6.4.18 *Refractometer* — An optical instrument for determination of the refractive index of a material.

6.4.19 *Saccharimeter* — A special type of polarimeter used for the estimation of sugar concentration by the measurement of the rotation of the plane of polarization by the specimen.

6.4.20 *Spectrograph* — A spectrograph is a modified spectroscope for photographic recording of spectra.

6.4.21 *Spectrometer* — An instrument with a collimator, telescope and a prism table, used for the evaluation of refractive indices by reading the positions of the telescope and prism table on an angular scale provided for the purpose.

6.4.22 *Spectrophotometer* — An instrument for the quantitative measurement of the relative intensity of radiation in different parts of its spectrum.

6.4.23 *Spectroscope* — An instrument designed for visual observation of spectra.

6.4.24 *Stereoscope* — An instrument that reveals the contours in relief and presents a solid/three dimensional view of the object.

7. DEFECTS AND ABERRATIONS

7.1 Aberration — Departure of an image formed by an optical system in point to point resemblance in colour, dimensional proportionality and form from the ideal image of the object.

7.2 Air Bubble — A defect in glass developed during glass manufacture due to small bubbles of gas getting entrapped in the melt.

7.3 Astigmatism — The defect in an optical system by which the image of an off-axis point object is drawn out into two mutually perpendicular lines at different distances along the central ray of the image forming bundle.

7.4 Balsam Colouration — Preponderance of the colour of the cementing material manifested in balsamed components.

7.5 Balsam Cracking (Starring Starting) — The presence of a discontinuity of the cemented film between optical components in the form of an irregular star or other shape.

7.6 Chromatic Aberration — Defect due to lack of coincidence of the component colour images of an object formed by a lens owing to dispersion.

7.7 Cloudiness — Turbidity of glass developed during its manufacture resulting in diminished transparency.

7.8 Coma — An extra axial aberration of optical systems where the image of a point object off the axis is drawn out into a comet like flare due to varying magnifications of the aperture zones of the system.

7.9 Cords — Heavy striæ; a defect in glass manufacture.

7.10 Curvature of the Image Field — A defect due to curvature of lens surfaces where a plane object perpendicular to the optical axis is brought to a focus on a curved surface.

7.11 Dead Metal/Stone — Small fragments of undissolved material, normally opaque, embedded in optical glass during its manufacture.

7.12 Defective Centring — Non-alignment of the geometric and optic axis of a lens or a system of lenses.

7.13 Dig — A shallow pit on a polished glass surface.

7.14 Dimming — Reduction of light transmission as a result of formation of an extraneous film on polished glass surfaces.

7.15 Distortion — A defect due to lateral magnification varying across the field resulting in dissimilarity in shape. This is of the following two types:

a) *Pin Cushion Type* — It is a distortion where the magnification increases with the increase of axial distance.

b) *Barrel Type* — It is a distortion where the magnification decreases with the increase of axial distance.

7.16 Filming — Formation of a greyish film on the surfaces of optical components due to deposition of volatiles or due to chemical action.

7.17 Fogging — Formation of a greyish film of moisture on glass surface due to condensation from humid atmosphere in contact.

7.18 Fungal/Mould Growth — Growth of fungi or moulds in the shape of tree-like structures on glass surfaces interfering with clear vision through the instrument.

7.19 Fungal Marks — Characteristic etch marks or patterns on polished glass surfaces due to growth of certain types of fungi.

7.20 Ghost Image — Spurious image of the object coming into the field of view due to undesirable reflections within the instrument.

7.21 Parallax — Apparent relative movement between two objects, two images or an object and an image when the observer's eye is shifted.

7.22 Pits — Innate defects in glass brought out as dents/pits on surface during processing (for example, breaking of air bubbles, removal of stones, etc).

7.23 Pyramidal Error — The departure from exact parallelism of the edges of a prism. It is measured as an angle between one of the surfaces and the opposite edge.

7.24 Reams — Final bands occurring in plate glass parallel to the direction of rolling and arising from the breaking up of the striæ during rolling.

7.25 Scratches — Small furrows caused by particles of abrasives on polished glass.

7.26 Seeds — Minute air bubbles.

7.27 Sleeks — Very fine scratches left by a polishing tool.

7.28 Spherical Aberration — A defect due to a bundle of rays of monochromatic light not being brought to the same focus by different zones of the lens.

7.29 Strain — A state caused by tension or stress induced in glass due to improper annealing during manufacture or due to faulty mounting during assembly of a component.

7.30 Striae Veins — Defects in glass due to nonhomogeneity of the melt resulting in slight differences in optical properties having the appearance of transparent threads in the material.

7.31 Water Marks — Light etching appearing as patches caused by prolonged contact of polished glass surface with moisture.

8. PARAMETERS AND TESTS

8.1 Absorption Coefficient — The ratio of the quantity of light absorbed to the total amount of light incident on the specimen.

8.2 Angular Magnification — Ratio of the angle subtended at the eye by the virtual image formed by an instrument to that subtended by the object itself.

8.3 Angular Subtence — The angle subtended at the eye or at the centre point of the first surface of an optical instrument by an extended object.

8.4 Aperture — An opening that allows passage of light through an optical instrument.

8.5 Aperture Stop — A diaphragm that limits the passage of a bundle of light rays through the instrument.

8.6 Artificial Star — A point source of light virtually located at infinity simulating a star under laboratory conditions.

NOTE — The size of the 'Star' should be smaller than the resolving power of the system.

8.7 Back Focal Length of a Positive Lens — The distance between the second focal point and the vertex of the lens nearest to it.

8.8 Binocular Parallax Difference Parallactic Angle — The difference in the angles subtended at the two eyes of a person by two different objects situated in space. This enables perception in depth.

8.9 Centre of Perspective — For a photographic lens, it is that point through which all straight lines connecting corresponding points of the object and image pass.

NOTE — When viewing a reproduction, the entrance pupil of the eye should be located at the centre of perspective at which the perspective was made.

8.10 Circle of Least Confusion — The smallest circle enveloping all the transmitted rays of a bundle in the vicinity of the focal plane.

8.11 Collimation — *see* 4.12.

8.12 Conjugate Points — Points so located with respect to an optical system that an object placed at the one will produce an image at the other.

8.13 Contrast — The relative variation in photographic density in a print or negative delineating light and shade.

8.14 Critical Angle — In case of refraction from a denser medium to a rarer medium, the angle of incidence for which the refracted ray just grazes over the surfaces of separation.

8.15 Definition — The clarity with which an object can be seen through an optical system and is dependent on the freedom from various aberrations.

8.16 Depth of Focus (Image Space) — The range in image space throughout which the image formed by an optical system remains in sharp focus without noticeable deterioration.

8.17 Depth of Focus (Object Space) — The range in object space throughout which any positional changes of the object do not noticeably affect the position of focus of the corresponding image.

8.18 Dioptre (Lensatic) — The unit of power of a lens. It is equal to the reciprocal of the focal length expressed in metres.

8.19 Dioptre (Prismatic) — The unit of power of a prism. It is equal to a deviation of one centimetre at a distance of one metre.

8.20 Entrance Pupil — The image of the aperture stop of an optical instrument formed by the optical elements on the object side.

8.21 Equivalent Air Path of the Medium — The path of travel of a ray in any medium other than air equated in terms of travel in air for the same time. It is expressed by the product of the refractive index of the medium and the distance travelled by the ray in the medium.

8.22 Equivalent Focal Length of a Lens or Combination of Lenses — The focal length of an equivalent thin lens which gives the same sized image of an object at infinity. It is measured by the distance between the second principal plane and second focal point of the system.

8.23 Equivalent Optical Path of the Medium — The path of travel of a ray in air equated in terms of its travel in the particular medium without altering the layout of the optical system. It is expressed by the quotient of the distance travelled and the refractive index of the medium.

8.24 Exit Pupil — The image of the entrance pupil by the optical system.

8.25 Field of View — The extent of the object space, in angular measure, that can be viewed through the instrument in any one setting.

8.26 F-Number — The ratio of the focal length to the aperture of the lens.

8.27 Focal Plane — The plane containing the focal point and perpendicular to the optical axis.

8.28 Hyperfocal Distance — The nearest object distance for which the image is sharp, when the lens is focussed for infinity.

8.29 Interocular Distance — The distance between the centres of exit pupils of a binocular instrument.

8.30 Least Distance of Distinct Vision — The minimum distance at which the eye can distinctly see an object with comfort.

8.31 Linear Magnification — The ratio of the linear size of the image to that of the object.

8.32 Magnifying Power of a Lens — The ratio of the angle subtended at the eye by the virtual image to the angle subtended by the object when placed at the least distance of distinct vision.

8.33 Mechanical Tube Length — The distance between the shoulder of the object glass and the upper end of the body tube against which the eyepiece flange rests in a microscope.

8.34 Nodal Plane — A pair of conjugate planes of unit angular magnification in a lens or lens combination. When a ray strikes the first nodal plane on the object side at a certain angle, it leaves from the second nodal plane at the same angle.

8.35 Numerical Aperture — An optical constant defined as being equal to the product of the refractive index of the object space and the sine of half the apical angle of the cone of light covered by the objective.

8.36 Optical Axis — An imaginary line passing through the centres of curvature of the various surfaces of the system.

8.37 Optical Centre — The point on the optical axis of a lens through which a ray of light passes undeviated.

8.38 Optical Path — A term used in wave optics for the product of the metric distance travelled by the wave and the refractive index of the medium.

8.39 Optical Tube Length — The distance between the adjacent focal planes of the objective and the eyepiece in a microscope.

8.40 Parallactic Angle — *see* **8.8.**

8.41 Primary Magnification — A term used in microscopy to denote the magnification effected by the objective.

8.42 Principal Plane — A pair of conjugate planes of unit linear magnification. When a ray strikes the first principal plane on the object side at a certain height, it leaves the second principal plane at the same height. These are also called *Unit Planes.*

8.43 Radius of Curvature — Radius of a sphere or cylinder of which the surface of the lens/mirror is a part.

8.44 Reflection Coefficient/Reflectance — The ratio of the quantity of light reflected to the total quantity incident on any reflecting surface.

8.45 Refractive Index of a Medium — The ratio of the velocity of light in vacuum to that in the medium.

8.46 Resolving Power — The minimum angular linear separation between two object points at which they can be observed as distinct and separate.

8.47 Stereoscopic Power of a Binocular Instrument — The product of the magnifying power of the instrument and the ratio of the distance between the centres of the two entrance pupils to the interocular distance.

8.48 T-Number — The photometric rating of the speed of a lens. It is defined as the 'F' Number of a fictitious lens of circular aperture having 100 percent transmittance which will give the same central illumination as the actual lens at the specified stop opening.

8.49 Transmission Coefficient/Transmittance — The ratio of the quantity of light passing through the specimen to the total quantity incident on it.

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